Aramco

DEEP SPACE

DEEP OCEAN

Aramco Technology and
Operational Excellence Forum

Using Generic Data to Establish Dormancy Failure Rates

Dormancy Failures

Suppose a probabilistic risk assessment includes some items that are subject to a significant dormant period prior to being operated (e.g., a mission to Mars).

One would expect the failure rate to be lower during a dormant period. But by how much?

An order of magnitude?
A factor of 30?

Possible Sources

- Non-Operational Databases (NONOP-1, 1987)
- MIL-HDBK 217
- 217Plus
- Conversion Factors

Conversion factors are typically intended to be used on electronic piece parts.

Sources—Continued

NPRD-2011 (Nonelectronic Parts Reliability Data)

- Some items contain the dormant environment
  - About 120—a very small percentage of the total number of items
- Probably not the items you're looking for

Dormant GRADS (Generic Risk Analysis Data Set)

Special Selections

Select/Deselect All Data Sheets ☐

Show Database Summay Sheet ☑

Show/Hide Data Sheets

DORMANT GRADS

Generic Risk Analysis Data Set

Version: 1.0
Date: 7/31/2013
Organization: JSC S&MA
Contact Name: Bruce Reistle
Contact Email: bruce.c.reistle@nasa.gov

A-C ☐	
Data Sheet Name	Show
Accelerometer	☐
Accumulator,Press,Hyd	☐
Actuator	☐
Actuator,Hydraulic	☐
Actuator,Linear	☐
Actuator,Pneumatic,Linear	☐
Antenna	☐
Arrestor,Surge,Spark Gap	☐
Attenuator	☐
Bearing	☐
Bearing,Ball	☐
Bellows	☐
Circuit Breaker	☐
Circuit Card Assembly,Populate	☐
Circuit Card Assmbly,Pop,Plated	☐
Connection,Solder	☐
Connection,Solder,Hand Lap	☐
Connector,Circular	☐
Connector,Circular,Multi-Cont	☐
Connector,Coaxial,FRRF	☐
Connector,Electrical	☐
Connector,PCB, Printed Circuit	☐
Connector,PWB, Printed Wiring	☐
Connector,Rectangular	☐
Counter,Timer	☐
Coupler,Antenna	☐
Coupler,Directional	☐
Crystal,Quartz	☐

D-H ☐	
Data Sheet Name	Show
Disk Drive,Floppy	☐
Disk Drive,Hard Disk	☐
Duct	☐
Duct,Air,Furnace	☐
Electron Tube	☐
Electron Tube,CRT	☐
Electron Tube,Klystron	☐
Electron Tube,Magnetron	☐
Engine	☐
Fan	☐
Fan,Axial	☐
Fan,Centrifugal	☐
Fasteners and Hardware	☐
Filter,Bandpass	☐
Filter,Fluid,Pressurized	☐
Fitting,Hydraulic,QD	☐
Flight Instrument	☐
Fuse,Enclosed Link	☐
Gas Generator	☐
Gasket	☐
Generator	☐
Generator,AC Voltage	☐
Generator,Gas Turbine	☐
Generator,Turbine	☐
Gyroscope	☐
Gyroscope,Rate	☐
Heater,Electrical,Resistive	☐
Hose,Hydraulic	☐

I-R ☐	
Data Sheet Name	Show
Igniter	☐
Igniter,Explosive	☐
Igniter,Explosive,Bolt	☐
Igniter,Explosive,Solid Prop	☐
Igniter,Explosive,Squib	☐
Inductive Device,Inductor,Micr	☐
Lamp,Neon,Miniature	☐
Manifold,Fluid	☐
Motor,AC	☐
Motor,Sensor	☐
Motor,Torque	☐
Motor Generator	☐
PCB, Printed Circuit Board,Pop	☐
PCB, Printed Circuit Board,Unp	☐
Pin,Connector	☐
Power Transmitter	☐
Pump,Hydraulic	☐
Pump,Hydraulic,Centrifugal	☐
Pump,Hydraulic,Fuel	☐
Pump,Hydraulic,Gear	☐
Pump,Hydraulic,Piston	☐
Pump,Hydraulic,Vane	☐
Recorder	☐
Regulator,Pressure,Hydraulic	☐
Relay,Electromagnetic	☐
Relay,Electromechanical,Gen	☐
Relay,Electromechanical,Latch	☐
Relay,Electromech,Reed,Dry	☐
Relay,Power	☐
Relay,Solenoid	☐
Relay,Thermal	☐

S ☐	
Data Sheet Name	Show
Seal	☐
Seal,O-Ring	☐
Seal,Packing	☐
Sensor,Motion,Acc,Angular	☐
Sensor,Motion,Acc,Linear	☐
Sensor,Motion,Acc,Pendulum	☐
Sensor,Pressure	☐
Sensor,Transducer	☐
Sensor,Transducer,Motion	☐
Solenoid	☐
Spring	☐
Switch	☐
Switch,Electronic	☐
Switch,Inertial	☐
Switch,Micro	☐
Switch,Pressure	☐
Switch,Pushbutton	☐
Switch,Rotary	☐
Switch,Rotary,Stepping	☐
Switch,Sensitive	☐
Switch,Sensitive,Micro	☐
Switch,Thermostatic	☐
Switch,Toggle	☐
Synchro,Resolver,Low Speed	☐

T-Z ☐	
Data Sheet Name	Show
Tank,Pressurized,Gas	☐
Transformer	☐
Transformer,Power,Single Phase	☐
Transformer,Power	☐
Transformer,Pulse	☐
Transformer,RF, Radio Freq	☐
Valve,Ball,Hydraulic	☐
Valve,Bypass,Hydraulic,Fuel	☐
Valve,Check,Hydraulic	☐
Valve,Check,Pneumatic	☐
Valve,Hydraulic,Solenoid	☐
Valve,Relief,Hydraulic	☐
Valve,Relief,Pneumatic	☐
Valve,Shut Off,Hydraulic	☐
Valve with Actuator,Pneumatic	☐

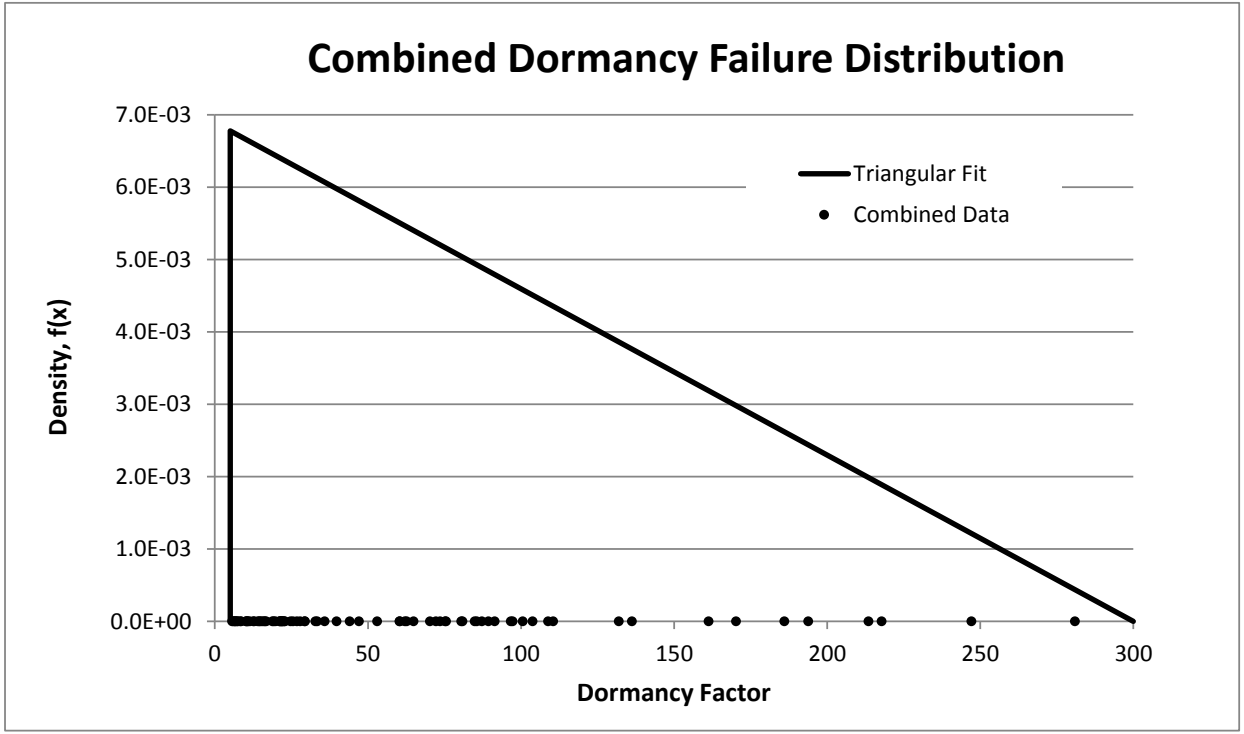
Dormant GRADS—Continued

Motor, AC		GRADS Rate Based Data Sheet (per hour)					
Environment	Count	Parameters for Lognormal(Mean, EF) and Gamma(α, β)					
		Mean	Error Factor	α	β	SD	Variance
Overall	1	2.2E-05	8.2	2.4E-01	1.1E+04	4.4E-05	1.9E-09
GF	3	1.1E-05	9.5	1.8E-01	1.7E+04	2.5E-05	6.2E-10
NS	2	2.4E-05	4.2	8.6E-01	3.7E+04	2.5E-05	6.4E-10
NSB	2	4.7E-07	5.6	5.0E-01	1.1E+06	6.7E-07	4.4E-13
G	1	3.1E-06	5.6	5.0E-01	1.6E+05	4.4E-06	1.9E-11
GB	1	5.2E-06	5.6	5.0E-01	9.5E+04	7.4E-06	5.5E-11
GM	1	2.8E-05	2.9	2.0E+00	7.2E+04	2.0E-05	3.8E-10
NU	1	1.2E-04	2.4	3.0E+00	2.5E+04	7.1E-05	5.0E-09
DOR	2	2.4E-06	8.6	2.2E-01	9.4E+04	5.0E-06	2.5E-11

Dormancy Factors

The dormancy factor is the ratio of the dormant failure rate to the combined active failure rate.

To focus on the central tendency of the data, only the 10th to the 90th percentiles are used.



Dormancy Factors—Continued

Triangular Distribution Details

Hardware Type	Minimum	Mode	Mean	Maximum
Electrical	2	2	50	150
Mechanical	10	10	310	900
Electro-Mechanical	10	10	110	300
Combined	5	5	100	300

Data Summary

Hardware Type	Data Points	10th	Mean	Data Mean	90th
Electrical	45	10	50	50	100
Mechanical	33	60	310	300	620
Electro-Mechanical	39	20	110	90	210
Combined	117	20	100	100	210

Using the Dormancy Factors

To model dormant failures using dormancy factor, you need:

1. The active failure rate
2. The dormant duration

The
It is important to capture the correct dormant time. In some cases the dormant time could go back as far as the date the item was manufactured. In general, dormant time is months or years.

Also, there might be compounding factors (corrosion, thermal stress, etc.) that would require additional analysis.

Conclusions

- These factors are ballpark estimates
- If you have better data, use it
- Use a reasonable estimate for the dormant period